Mark schemes

1

(a) 36 cm^3

1

(b) all points correct

± ½ small square

2

*allow **1** mark if 6 or 7 of the points are correct*

2 best fit lines drawn

must not deviate towards anomalous point

2

*allow **1** mark if 1 line correct*

(c) The bung was not pushed in firmly enough.

1

The measuring cylinder was not completely over the delivery tube.

1

(d) as mass of lithium carbonate increases volume of gas produced increases

1

linear / (directly) proportional

1

(e) A gas / carbon dioxide is produced.

allow because the air in the tube expands

1

(f) any **one** from:

- Potassium carbonate does not decompose to produce carbon dioxide / a gas.
- Potassium carbonate does not decompose at the temperature of the Bunsen burner **or** the Bunsen burner is not hot enough to decompose potassium carbonate.
- When potassium carbonate decomposes a gas is not formed.

1

[11]

2

(a) $N_2 + 3\ H_2 \rightarrow 2\ NH_3$

1

(b) catalyst

1

(c) as pressure increases percentage yield increases

1

(d) 32−23

both readings correct

1

= 9 (%)

1

[5]

3 (a) cotton wool

1

(b) all points correct

± ½ small square

2

*allow **1** mark if 5 or 6 of the points are correct*

best fit line

must not deviate towards anomalous point

1

(c) (mass)
2.1 (g)

allow ecf from drawn best fit line

1

(time)
100 (s)

1

(d) a gas is produced

1

which escapes from the flask

1

(e) $\frac{9.85}{150} = 0.0656$

1

0.07 (g / s)

allow ecf answer correctly calculated to 2 decimal places

1

(f) collect the gas in a gas syringe

1

measured the volume of gas

allow carbon dioxide for gas

1

*allow for **1** mark*
collected gas
or
counted bubbles

(g) The particles have more energy

1

The particles move faster

1

[14]

4 (a) $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

2

*allow **1** mark for correct formulae*

(b) sensible scales, using at least half the grid for the points

1

all points correct

± ½ small square

*allow **1** mark if 8 or 9 of the points are correct*

2

best fit line

1

(c) steeper line to left of original

1

line finishes at same overall volume of gas collected

1

(d) acid particles used up

allow marble / reactant used up

1

so concentration decreases

allow surface area of marble decreases

1

so less frequent collisions / fewer collisions per second

*do **not** accept fewer collisions unqualified*

1

so rate decreases / reaction slows down

1

(e) mass lost of 2.2 (g)

1

time taken of
270 s

allow values in range 265 − 270

1

$$\frac{2.2}{270} = 0.00814814$$

allow ecf for values given for mass and time

1

0.00815 (g / s)

or

8.15×10^{-3}

*allow **1** mark for correct calculation of value to 3 sig figs*

*accept 0.00815 or 8.15×10^{-3} with no working shown for **4** marks*

1

(f) correct tangent

1

eg 0.35 / 50

1

0.007

allow values in range of 0.0065 − 0.0075

1

7×10^{-3}

1

*accept 7×10^{-3} with no working shown for **4** marks*

[20]

5 (a) sulfur / sulphur / S / S(s)

1

(b) as the temperature increases, the rate of reaction increases

allow two correct values for rate quoted (from graph) at different temperatures

1

the rate of increase increases **or** there is an exponential relationship

*accept the rate of reaction increases slowly (from 20 °C to 50 °C) then increases more rapidly for **2** marks*

answer MUST be based on rate / speed of reaction

1

(c) (i) any **two** from:

- temperature (of the reactants)
- concentration of hydrochloric acid
- volume of hydrochloric acid
- volume of sodium thiosulfate
- the (size / darkness / thickness of the) cross
- total volume of solution.

*if no other marks gained, allow **1** mark for:*

rate of stirring

OR

amount of hydrochloric acid / sodium thiosulfate

OR

volume of solution

2

(ii) (because as the concentration increases) the number of particles per unit volume increases **or** particles are closer together.

idea of more particles in a given space is required for the first mark.

ignore references to area.

1

(therefore) the frequency of (successful) collisions increases

allow increased chance / probability of collisions

number of collisions increases is insufficient here.

***must** mention per unit time or frequency.*

ignore speed of collisions.

if reference to space and time missing from M1 and M2 but they are otherwise correct, then award 1 mark.

1

so the number of particles (per unit volume) doubles **or** (the frequency of) collisions doubles.

*students can score **2** marks for a qualitative explanation; the third mark is for a quantitative explanation.*

1

[8]

6 (a) (i) 25 °C

1

(ii) (fractional) distillation

1

(b) (i) (fertile) land is used to grow fuel crops **or** crops are grown for fuel **or** farmers get a better price for crops for fuel **or** crops for biofuels take up space

ignore biofuels are made from food or plants

1

less food grown **or** food prices rise **or** less (fertile) land to grow food

1

(ii) (crops / plants) take in carbon dioxide (while growing / during photosynthesis)

1

so the CO_2 given out was previously taken in

*do **not** accept burning biofuels does not release CO_2 or releases less CO_2 unqualified*

*if no other mark awarded, a statement of "carbon neutral" scores **1** mark*

1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a 'best–fit' approach to the marking.

0 marks
No relevant content

Level 1 (1−2 marks)
At least one statement about the effect of a condition on either rate **or** yield.

Level 2 (3−4 marks)
Correct statements about the effect of at least one condition on rate **and** yield.

Level 3 (5−6 marks)
Correct statements about the effect of at least one condition on rate and yield **and** at least one correct statement about compromise conditions.

Examples of the points made in the response

Temperature
- a higher temperature gives a lower yield
- a higher temperature gives a faster rate

Pressure
- a higher pressure gives a higher yield
- increase in yield gets less as pressure increases
- a higher pressure gives a faster rate
- increase in rate increases as pressure increases

Catalyst
- using a catalyst speeds up reaction
- catalysts allow a lower temperature to be used and so save energy / reduce energy costs

Compromise
- a higher pressure gives a greater yield but increases costs / (safety) risks
- a high pressure gives a faster rate but increases costs / risks
- a high temperature makes reaction faster but reduces yield
- a catalyst makes reaction faster so a lower temperature can be used which will increase the yield

6

[12]

7 (a) (i) the higher the temperature, the greater the rate
or
at 40 °C rate is faster than at 20 °C
accept the higher the temperature, the faster the reaction
1

(ii) 40 °C curve is steeper
accept the 40 °C line becomes horizontal sooner
accept at higher temperatures the reaction finishes sooner
accept reaction finishes sooner at 40 °C
accept at higher temperatures the gas is produced faster
or
correct comparison of data from the graph
1

(iii) 2
1

(b) (i) Concentration of acid
Mass of marble chips
2

(ii) increases rate
*incorrect reference to energy = max **1***
1

(because of) more frequent collisions (between particles)
accept particles are more likely to collide
ignore more collisions
ignore more successful collisions
1

(c) any **one** from:
- increases rate of reaction
- reduces energy required
- lower temperature can be used
- catalyst is not used up.

1
[8]

8 (a) (i) nothing can enter **and** nothing can leave the reaction
allow sealed reaction vessel
1

(ii) forward and backward reactions have same rate
1

so there is no (overall) change in quantities of reactants and products
allow concentrations of reactants and products
1

(b) (i) natural gas

allow methane / CH_4

allow fossil fuels / hydrocarbons

allow water

1

(ii) provides an alternative reaction pathway

1

which has a lower activation energy

ignore references to collisions

1

(iii) the amount (of ammonia) increases

allow yield increases

1

the equilibrium moves to the side (of the equation) with fewer (gaseous) molecules / moles

allow it favours the forward reaction

1

(c) (i) vertical arrow from reactants to maximum

1

(ii) (energy of) products higher than (energy of) reactants

allow converse

1

(iii) amount of hydrogen iodide decreases

1

equilibrium moves in the direction of the endothermic reaction

allow it favours the forward reaction

1

[12]

9 (a) (i) covalent

1

(ii) increases the rate of reaction

1

(b) (i) the reaction is reversible

1

(ii) at lower pressure the molecules will be further apart

1

so there will be fewer collisions <u>per unit time</u>

accept frequency of collisions lower

1

(iii) as the temperature increases, the yield of the reaction increases

1

(iv) 2 molecules / volumes become 4 **or** more molecules / volumes **of** product than reactant

1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 – 2 marks)
Candidate has written about some basic points from the table but has not added any extra knowledge. Candidate may have included advantages **or** disadvantages.

Level 2 (3 – 4 marks)
Candidate has attempted an evaluation using points from the table and their own knowledge. Candidate has included advantages **and** disadvantages.

Level 3 (5 – 6 marks)
Candidate has given an evaluation that includes both advantages and disadvantages. Candidate has clearly linked points from the table with their own knowledge and uses appropriate scientific terminology.

examples of the points made in the response

Advantages of using hydrogen:

- its combustion only produces water
- combustion of hydrogen does not produce carbon dioxide **or** does not contribute to climate change
- petrol requires much more oxygen to burn so partial combustion is possible producing carbon monoxide
- combustion of hydrogen does not produce any particulates **or** does not contribute to global dimming
- petrol comes from a non-renewable source **or** there are renewable ways of producing hydrogen, eg electrolysis of water.

Disadvantages of using hydrogen:

- hydrogen has to be stored at high pressure **or** risk of explosion or larger volume needed for storage.
- much less energy produced from the combustion of hydrogen **or** need to refuel more often
- most methods of producing hydrogen need fossil fuels.

6

[13]

10 (a) any **two** from:

- temperature (of the HCl)
- mass or length of the magnesium
- surface area of the magnesium
- volume of HCl

2

(b) (i) (a greater concentration has) more particles per unit volume

allow particles are closer together

1

therefore more collisions <u>per unit time</u> **or** more frequent collisions.

1

(ii) particles move faster

allow particles have more (kinetic) energy

1

therefore more collisions <u>per unit time</u> **or** more frequent collisions

1

collisions more energetic (therefore more collisions have energy greater than the activation energy) **or** more productive collisions

1

(c) (i) add (a few drops) of indicator to the acid in the conical flask

allow any named indicator

1

add NaOH (from the burette) until the indicator changes colour **or** add the NaOH dropwise

candidate does not have to state a colour change but penalise an incorrect colour change.

1

repeat the titration

1

calculate the **average** volume of NaOH **or** repeat until concordant results are obtained

1

(ii) **moles of NaOH**

$0.10 \times 0.0272 = 0.00272$ moles

*correct answer with or without working gains **3** marks*

1

Concentration of HCl

$0.00272 / 0.005 = 0.544$

allow ecf from mp1 to mp2

1

correct number of significant figures

1

[14]

11 (a) left hand: (conical) flask

*do **not** accept round bottomed flask or container which is not a flask*

1

right hand: beaker / trough

accept plastic box

1

(b) (i) 157

1

(ii) all calcium carbonate used up **or** reaction stopped

*do **not** accept all acid used up*

1

(c) (i) 0.007(272727…)

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow (0.32 / 44) for **1** mark*

2

(ii) 0.007(272727…)

*allow ecf from **(c)(i)***

1

(iii) (M_r = mass / moles = 1 / 0.00727…) = 137.5 or 138

*allow ecf from **(c)(ii)***

if use 0.00943 moles then = 106

if use 0.007 allow 143 (142.857)

1

(iv) (138) – 60 (= 78)

23 / 85

1

(78 / 2) = 39

1

potassium

sodium / rubidium

*identity of metal ecf on A_r, but **must** be Group 1*

*If no working max **1** mark*

1

(d) (i) (relative atomic mass) would decrease

1

because the mass lost greater

1

so moles carbon dioxide larger **or** moles metal carbonate greater

1

(ii) no change

1

because the acid (already) in excess

1

so the amount carbon dioxide lost is the same

1

[17]

12 (a) (i) precipitation

1

(ii) (aq) on left hand side

1

(s) on right hand side

1

(iii) potassium iodide

1

potassium nitrate

1

(iv) filtration

1

(b) (i) diffusion

1

(ii) iodide ions move / diffuse faster than lead ions **or** travel further in the same time

Must be a comparison

Accept converse

1

because the lead iodide forms much closer to the lead nitrate (or **X**) than the potassium iodide (or **Y**).

allow because iodide ions are smaller than lead ions

allow references to potassium iodide and lead nitrate

1

(iii) the particles / ions move / diffuse faster

ignore which particles / ions the student refers to

1

because they have more energy **or** will collide / meet sooner

ignore reference to frequency of collisions

1

[11]

13 (a) the forward and backward reactions occur

allow reversible

1

at (exactly) the same rate

1

in a closed system

allow therefore the concentrations / amounts of the reactants and products remain the same

1

(b) (i) increasing the temperature would lower the yield of ethanol **or** the (position of) equilibrium moves to the left

*if student has stated that increasing the temperature increases the yield then award **0** marks*

1

since the backwards reaction is endothermic **or** the forward reaction is exothermic

1

(ii) increasing the pressure would increase the yield of ethanol **or** the (position of) equilibrium moves to the right

*if student has stated that increasing the pressure decreases the yield then award **0** marks*

1

because the position (of equilibrium) moves in the direction of the lower number of moles (of gas)

2 (moles / molecules / volumes / particles) on lhs / 1 (mole / molecule / volume / particle) on rhs

1

(c) (a catalyst) provides an alternative pathway

1

with lower activation energy

or

(a catalyst) lowers the activation energy (1)

so less energy is needed to react **or** more particles react (1)

1

[9]

14 (a) (i) brown

1

(ii) oxygen + iron + water $\longrightarrow$ hydrated iron oxide / rust

allow correct symbol equation

ignore oxidation numbers for product

1

(b) (i) 32.3

1

(ii) 7.6

ecf from (b)(i)

1

(iii) do not know start volume of air

1

because the burette not graduated to the end

allow iron wool takes up some of the space

*if no other marks awarded accept all iron may have rusted (**1**) **or** still some oxygen left / not all used up (**1**)*

1

(c) (i) gains oxygen and water **or** oxygen and water are added

allow reacts with or gains oxygen

allow reacts with or gains water

allow reacts with or gains elements which add to mass

ignore iron oxide forms

1

(ii) as temperature increases (from 10 °C to 42 °C or to 50 °C) the increase in mass of nail increases

accept positive correlation

accept mass increases

1

rate of increase gets faster as temperature goes up

accept exponential
ignore non linear

1

no further increase at temperatures over 42 °C

accept no further increase at high temperatures

*exponential increase scores **2** marks*

1

(iii) use a (bigger) flask **or** let air into the tube **or** leave for less time **or**

ignore more water

1

to make sure sufficient oxygen / air **or** not all oxygen used up

accept converse

*if no other marks awarded allow change in surface area for rusting **or** change in number of nails for **1** mark*

1

[12]

15 (a) (i) oxygen, sulfur trioxide

both needed for mark

1

(ii) compound

1

(b) increases

accept (goes) higher / (goes) up / (is) faster) / (are) more frequent

1

(c) activation

1

(d) catalyst **or** increase temperature

1

[5]

16 (a) **O_2** in correct space

1

correct balancing

accept multiples

1

(b) (i) rate increases

*incorrect reference to energy = max **2***

ignore references to equilibrium

1

because particles are closer together

accept because there are more particles (per unit volume)

allow particles have less space / room to move around

1

so frequency of collisions increases

accept particles are more likely to collide

ignore more collisions

ignore more successful collisions

1

(ii) has a greater surface area

1

so the reaction is faster

accept so more frequent collisions

1

(c) the (minimum) amount of energy (particles must have) to react ***or** to start a reaction*

accept the energy needed to break bonds

ignore references to heat

1

(d) (i) (potassium is) too / *very* reactive

ignore potassium is a Group 1 / alkali metal

1

so dangerous / *violent reaction*

accept hydrogen produced rapidly

1

(ii) $ZnSO_4$

accept products in either order

ignore names of substances

1

H_2

*do **not** accept brackets or charges in the formulae*

1

(iii) any **one** from:
- increase concentration (of sulfuric acid)
- increase temperature **or** heat it
- increase surface area of zinc

1

[13]

17 (a) time from when the heating is started until

1

the limewater turns cloudy / milky

1

(b) (i) the temperature was not high enough

accept the copper carbonate had not started to decompose / react

accept it takes time to heat up the copper carbonate

1

the bubbles of gas were air

accept no carbon dioxide produced

1

(ii) the copper carbonate was decomposing / reacting

accept the temperature was high enough to cause decomposition / a reaction

1

so carbon dioxide was produced

allow correct word / symbol equation

1

(iii) copper oxide was produced

allow correct word / symbol equation

1

because the copper carbonate had <u>completely</u> decomposed / reacted

ignore all of the carbon dioxide had been given off

1

[8]

18 (a) would melt

accept they have a low melting point

allow lose their shape

ignore would soften when hot

ignore boiling point

1

(b) to speed up the reaction

accept can use a lower temperature

accept less energy needed

1

(c) (i) mass spectrometer

allow mass spectroscopy

1

(ii) any **one** from:

ignore reliable

ignore more precise

- accurate
- sensitive
- rapid / quicker
- small amount of sample

1

(d) any **two** from:

allow concentration

- pressure
- temperature
- catalyst **or** initiator
- solvent

2

[6]

19 (a) because sulfur / S forms

1

which is insoluble / a solid / a precipitate

1

(b) (i) 32

*correct answer with or without working gains **2** marks*

*accept evidence of 31 + 33 / 2 for **1** mark*

*allow 35 for **1** mark*

2

(ii) reaction rate increases

*if incorrect reference to energy = max **2***

1

because of more particles (per unit volume)

allow because particles are closer together

1

and because there is an increase in frequency of collisions

*accept because particles are more likely to collide **or** higher chance of collision*

ignore more (successful) collisions

1

[7]

20 (a) heat / energy

1

given out / transfers to surroundings

the mark for given out / transfers to cannot be awarded without heat / energy

allow given off

1

(b) (i) decreases

1

increases

1

(ii) it gives the particles more energy

1

it makes the particles move faster

1

[6]

21 (a) (i) a continuous straight line missing anomalous point

allow a line which does not start at zero / origin

1

(ii) any **two** sensible errors eg

*ignore systematic / zero error / weighing error **or** error unqualified*

- timing errors and / or example
- measurement errors and / or example
- apparatus errors and / or example
- human / experimental / reading / random error and / or example or 'did not do it right'

*could be two from **same** category*
eg two timing errors – watch not started at the same time plus difficulty in deciding when the cross has disappeared.

- temperature fluctuation
- anomalous point

accept outlier / wrong result

- results not recorded correctly
- plotting error
- rate calculated incorrectly

ignore 'not repeated'

2

(b) (i) straight line

*allow as concentration increases the rate goes up **or** converse*
allow numerical example
allow positive correlation
allow same gradient
ignore 'most points near / on line of best fit'

1

(ii) because of an increase in frequency of collisions

*max **1** if incorrect reference to energy **or** if subatomic particle specified*
accept because particles are more likely to collide or higher chance of collision
ignore more (successful) collisions

1

because there are more particles (per unit volume)

allow because particles are closer together

1

[6]

22 (a) (i) In suntan creams

1

(ii) Much smaller

1

(b) (i) have a high surface area to volume ratio

1

(ii) because a catalyst provides an alternative / different pathway / mechanism / reaction route

accept adsorption or 'increases concentration at the surface' ignore absorption

1

(that has) lower activation energy

allow weakens bonds

allow idea of increased successful collisions

*max **1** mark for incorrect chemistry eg increased energy of particles*

1

[5]

23 (a) three bonding pairs

*do **not** allow non-bonding electrons in hydrogen*

ignore any inner shells on nitrogen

1

two non-bonding electrons

allow either dots and crosses or combination of both

1

(b) (i) nitric

1

(ii) fertilisers / explosives

ignore other uses

1

(iii) 80

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow 14 + (1 × 4) + 14 + (16 × 3) for **1** mark*

2

(iv) 35

*allow ecf from **(b)(iii)***

*allow ecf for **1** mark for correct working but incorrect answer.*

*if answer incorrect, allow 28 / 80 × 100 for **1** mark*

*if answer is 17.5 % allow **1** mark*

2

(c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best−fit' approach to the marking.

0 marks
No relevant content

Level 1 (1 − 2 marks)
There are statements about the conditions used. There is no correct explanation of the link between rate or yield and the conditions.

Level 2 (3 − 4 marks)
There is a correct explanation of the conditions used that links the conditions to rate **or** yield

Level 3 (5 − 6 marks)
There is an explanation covering at least temperature and pressure, which shows understanding of the compromise between rate **and** yield

examples of chemistry points made in the response:

200 atmospheres pressure
- high pressure gives a high yield of ammonia
- too high a pressure causes risk of explosion
- high pressure costly to maintain
- a high pressure will cause the rate to be higher
- 4 moles of gas become 2 (or fewer moles of gas in products)

450 °C
- high temperature increases the rate of reaction
- optimum temperature
- (forward reaction is exothermic so) a high yield of ammonia requires a low temperature
- but too low a temperature causes the rate of reaction to be too slow

iron catalyst
- a catalyst speeds up the reaction
- an iron catalyst allows a lower temperature to be used (saving energy and causing a higher yield)
- iron catalyst increases the rate of reaction equally in both reactions

others
- compromise conditions
- unreacted nitrogen and hydrogen is recycled

6

[14]

24 (a) (s) (aq) (aq) (g)

must be in this order

***2** marks if all four correct*

***1** mark if 2 or 3 correct*

2

(b) (i) 55

ignore units

1

(ii) 54

*allow ecf from **(b)(i)***

1

(iii) 0.92

*correct answer with or without working gains **2** marks*
*ecf from volume in **(b)(i)***
accept 2 d.p. up to calculator value
*if answer incorrect, allow rate = (b)(i) / 60 for **1** mark*

2

(c) (i) circle round point at (48,22)

1

(ii) problem (1) and explanation (1)

*explanation **must** give lower volume of gas or slower reaction*
ignore human error unless qualified

problem with bung

e.g. bung not placed in firmly / quickly enough

so gas lost

or

problem with reagent

e.g. acid was diluted **or** acid not replaced

so reaction slower

or

problem with temperature

e.g. temperature was lower than recorded temperature

so reaction slower

or

problem with measurement

e.g. length of magnesium less than 8 cm **or** timed for less than a minute

so less gas produced

2

(d) repeat the experiment (several times)

1

because anomalous results could be excluded

1

and then the mean can be determined / calculated

*accept suggestion of alteration to method, which is explained as to why it would reduce the error, for **3** marks (e.g. place the magnesium in a container within the flask (1) so it can be tipped into the acid once the bung is in place (1). This will prevent anomalous results or gas loss (1))*

ignore idea of more accurate gas syringe
ignore shorter time intervals

1

(e) (i) use clean magnesium **or** use magnesium without oxide coating

1

compare results

1

(ii) **either**

measure the temperature of the acid before (adding magnesium)

1

and after adding magnesium

or

place the conical flask in a water bath (at 40 °C) (1)

compare results (1)

1

[16]

25 (a) any **two** from:

- effervescence / bubbles / fizzing

  allow gas / hydrogen is given off
  allow volume of gas

  allow magnesium floats

- magnesium disappears / dissolves

  allow change in mass of magnesium

- heat given off / exothermic

  allow temperature change
  *do **not** accept temperature decreases*

- change in pH

  *do **not** accept pH decreases*

2

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks
No relevant content.

Level 1 (1-2 marks)
A simple plan without reference to changing any variable but should include an attempt at measuring rate **or** an attempt at fair testing

Level 2 (3-4 marks)
A plan including change of concentration / 'volume' of acid **and** should include an attempt at measuring rate **and** / **or** an attempt at fair testing

Level 3 (5-6 marks)
A workable plan including change of concentration **and** measurement of rate **and** fair testing

Examples of chemistry points made in the response could include:

Plan:

- add magnesium to acid
- time reaction / 'count bubbles' / measure volume of gas
- change concentration / 'volume' of acid

Control Variables:

- amount / mass / length / same 'size' of magnesium
- volume / amount of acid

6

[8]

26 (a) (i) 10

1

(ii) OH^-

1

(b) (i) air

1

(ii) particles move faster

1

particles collide more often

1

(iii) catalyst(s)

1

(c) liquid

1

[7]

27 (a) oxygen **and** water

both needed for mark

allow hydrogen oxide for water

in any order

ignore formulae

1

(b) (i) best fit line, omitting point at 10s

straight line drawn through all correct points

1

(ii) circle around point at 10 s

allow any indication

1

(iii) 7.5

allow ecf from candidate's line

1

(iv) increases (with time)

accept goes from 0 to 12.5

1

(c) (i) higher

1

(ii) more concentrated

1

(d) (i) share

1

(ii) covalent

1

(iii) simple molecules

1

(e) Water has a boiling point of 100°C

1

Water has a melting point lower than room temperature

1

[12]

28 (a) gives out energy **or** heat

1

(b) (i) *accept qualified answers in terms of volume of gas related to time*

fast initially

1

slows down

1

reaction stops

accept reaction is now very slow

1

(b) (ii) 21

1

(iii) 84

*correct answer with or without working = **2** marks*

*allow ecf from (b)(ii) correctly calculated for **2** marks*

*allow evidence of 21/25 **or** (b)(ii)/25 for **1** mark*

2

(c) because they / particles have more energy / move faster

ignore particles move more / vibrate

1

(and so) particles collide more often / more frequently **or** particles more likely to collide

ignore collide faster

ignore more collisions

1

(and) more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy

accept more successful collisions

1

[10]

29 (a) 118

1

(b) it loses / transfers electrons

it = Au / gold atom

1

three electrons

*sharing / covalency = max **1** mark*

1

(c) (i) O_2

1

2 CO and **2** CO_2
or
correct balancing of equation from O
accept correct multiples / fractions throughout

1

(ii) *reference to incorrect bonding = **1** mark max*

because carbon dioxide is simple molecular / small molecules

1

there are *intermolecular* forces (between the molecules)
allow intermolecular bonds

1

so a small amount of energy needed (to separate molecules) **or** (*intermolecular forces*) are weak

1

(d) any **three** from:

- gold is the only catalyst for some reactions
- catalysts are not used up
- improves speed of reaction

  reduces amount of energy **or** process needs low(er) temperature
  *if no mark awarded, allow catalyst reduce costs (of the process) for **1** mark*
- only small quantities (of catalyst) needed

3

[11]

30 (a) (i) the temperature at start
ignore reference to bubbles / heat

1

the temperature at end
*(measure) the temperature rise / change = **2** marks*
*(measure) the temperature **1** mark*

1

(ii) temperature would increase
allow it gets hot(ter) / warm(er) or heat given off
allow energy released / transferred

1

(b) any **one** from:

- volume of acid
  allow amount
  allow liquid
- temperature of acid
- size of magnesium ribbon
  allow volume / mass / amount
- surface area of magnesium
  ignore size of test tube and reference to water

1

(c) (i) (Test tube) B

1

(ii) produces bubbles faster
accept more bubbles

or
faster rate of reaction
allow most reactive

1

(d) The particles move faster

1

The particles collide more often

1

[8]

31 (a) mixture is cooled / cooling

1

so ammonia / it condenses

or
so ammonia <u>turns into</u> a liquid (but nitrogen and hydrogen remain as gases)

1

(b) (i) exothermic reaction
accept reverse reaction is endothermic

or
equilibrium / reaction moves in the direction which raises the temperature
ignore answers based on rate or collisions

1

(ii) they / particles / molecules move faster **or** have more (kinetic) energy

allow atoms instead of particles

ignore particles move more / vibrate

*do **not** accept electrons (max1)*

1

any **one** from:

- particles / molecules collide more often / more frequently / more likely to collide

  ignore collide faster

  ignore more collisions

- more of the collisions are successful **or** particles collide with more energy / harder **or** more of the particles have the activation energy

  accept more successful collisions

1

(iii) more molecules / particles / moles / volumes on LHS (of equation than RHS)

accept 4 molecules / particles / moles / volumes on LHS and 2 molecules / particles / moles / volumes on RHS

or

greater volume on LHS (than RHS)

or

equilibrium / reaction moves in the direction which reduces the pressure / volume

accept converse

1

(iv) cost

or

difficulty in containing such a high pressure

allow risk of explosion

ignore dangerous

1

(c) (i) 60

1

(ii) 2.4(2857….)

*correct answer gains **3** marks with or without working*
accept any answer that rounds to 2.4
ignore units
*if answer is incorrect look for evidence of correct working to a maximum of **2** marks.*
moles of N_2 = 2/28 = (0.0714)
moles of ammonia = 2 × 0.0714 = (0.1428)
mass of ammonia = 0.1428 × 17 = (2.4276)
or
28 → 34
1g →34/28
2g →2.4… …..

3

(d) (i) 15

1

(ii) unreacted gases are recycled

allow unreacted gases are reused

1

rate (of production) is fast

accept production is continuous
ignore compromise between rate and yield

1

[14]

32 (a) (i) increase

1

(ii) energy is given out to the surroundings

1

(b) (i) NO

allow 2NO
ignore nitrogen oxide
*do **not** allow equations*

1

(ii) harmful / poisonous (owtte)

allow dangerous
ignore reference to pollution / global warming
*do **not** accept references to ozone layer*

1

(c) a catalyst can speed up a chemical reaction

1

different reactions need different catalysts

1

(d) (i) smaller

accept less / tiny / very small

allow 10^{-9}

*do **not** allow small unless qualified*

1

(ii) reduce cost (owtte) **or**

ignore references to energy

save resources / raw materials (owtte)

1

[8]

33

(a) gives out heat / energy

allow release / loses

allow the products have less energy

or

energy / heat transferred to the surroundings

ignore temperature rises

allow more energy given out in forming bonds than taken in to break bonds

1

(b) (i) speed up the reaction (owtte)

accept changes the rate

accept lowers activation energy

accept increases successful collisions

accept allows reaction to take place at a lower temperature

1

(ii) nitrogen (N_2) / oxygen (O_2) / products are safe **or** not harmful / pollutant / toxic / dangerous / damaging

ignore releases nitrogen / oxygen unless qualified

or

(harmful) nitrogen monoxide / NO is not released into the air.

accept prevents / less acid rain

ignore greenhouse gas / ozone layer

1

(iii) 2 and 2

accept correct multiples or fractions

1

(iv) idea of catalyst not being used up

allow not changed by reaction

ignore catalyst does not take part

ignore catalyst not used in the reaction

1

(v) idea of different reactions (require different catalysts)

accept catalysts work for specific reactions

allow different gases

1

(c) • smaller / very small / or any indication of very small / 1–100 nanometres / a few (hundred) atoms

ignore just small

ignore size of the converter

1

• big(ger) surface area

1

• less (catalyst) needed / small amount of catalyst needed

1

[9]

34 use a more concentrated solution of sulfuric acid

1

grind the phosphate rock into a powder before adding the acid

1

increase the temperature of the sulfuric acid

1

[3]

35

(a) particles move faster

accept molecules / atoms / ions instead of particles

or

particles have more energy

ignore move / vibrate more

1

so they collide more often / frequently

allow particles collide harder / with more force

ignore collide quicker

or

more of the collisions are successful / have the activation energy

ignore collide more / more collisions

1

(b) any **one** from:

- increase surface area (of the rock)

  accept crush / powder the rock

- increase the concentration (of the acid)

  ignore increase the pressure / temperature

- add a catalyst

- stir / mix the mixture

1

[3]

36

(a) goes up

1

(b) (i) B

1

(ii) A

1

(iii) a catalyst

1

activation energy

1

(c) (i) eg (ensures) complete reaction

allow spread heat / energy

or even heating

allow mixes properly or mix them together or to get correct temperature

ignore dissolves

1

(ii) lid (on beaker)

accept cover beaker

or

insulate (beaker) / use a plastic cup

1

[7]

37 (a) energy released from making (new) bonds is greater than the energy needed to break (existing) bonds

accept the energy needed to break (existing) bonds is less than the energy released in making (new) bonds

*do **not** accept energy needed to make bonds*

1

(b) (i) energy / heat of products less than energy of reactants

accept products are lower than reactants

***or** reactants higher than products*

accept more energy / heat given out than taken in

***or** less energy / heat taken in than given out*

accept energy / heat is given out / lost (to the surroundings)

allow produce heat

ignore produce energy

accept ΔH is negative

***or** energy change / **A** is negative*

or B** is less than **C

1

(ii) **B** is (very) high / large

*it = **B***

*ignore energy change **C** is high*

1

(iii) *it = MnO_2*

(MnO_2) catalyst (is added)

accept it is a catalyst

or reaction catalysed (by MnO_2)

*do **not** accept MgO / magnesium oxide*

1

which lowers activation energy

accept provides alternative / lower energy pathway

or which lowers (energy change) **B**

if hydrogen peroxide is given as a catalyst instead of MnO_2 penalise once only in question

1

(c) any **two** from:

- (chemicals) not mixed / stirred
- heat / energy lost (from apparatus)
- (apparatus) not insulated **or** no lid
- low amount / mass / not enough MnO_2 **or** low concentration H_2O_2
- thermometer read incorrectly

ignore other experimental error

2

[7]

38

(a) (i) mix (owtte)

accept to allow more collisions / helps particles to collide (owtte)

idea of more efficient heat transfer

*do **not** allow heat is a catalyst*

1

(ii) higher **and** more

1

powder **and** big

1

concentrated **and** more

1

(b) electrons

1

(c) H^+

1

[6]

39 (a) (i) 0.2

*correct answer gains **2** marks with or without working*
accept answer in table
*if answer incorrect 5/25 gains **1** mark*

2

(ii) any **one** from:

- wider range of temperatures (owtte)
- (repeat at the same temperature) to improve accuracy / reliability
  allow to make it reliable / accurate
- reveal anomalous results (owtte)
  allow to eliminate random / human errors / to check results owtte
- so you can get an average / better average
  ignore to make it a fair test / to get better results
  ignore precision and validity

1

(b) any **two** from:

allow atoms / molecules / they instead of particles throughout

- particles gain energy / have more energy
  ignore increases particles activation energy
- particles move faster
  ignore move more / vibrate more
- particles collide more
- more of the particles have the activation energy **or** more of the collisions are successful (owtte)
  ignore increases / decreases activation energy

or

particles <u>collide</u> with more force / harder / more energy
allow more successful collisions
*alone for **1** mark*

2

[5]

40 (a) the glow stick is brighter (owtte)

*accept glow stick is less bright **at low temperatures** (owtte)*
ignore references to rate / particles

1

(b) gave out light for less time

accept use of figures from table for comparison

allow reference to speed / rate eg quicker / faster reaction

1

(c) the particles will collide more often

1

the particles will move faster

1

the particles will have more energy

1

(d) any **one** from:

repeat

allow more glow sticks

measure brightness eg use light meter

more temperatures **or** wider range

improve precision

1

[6]

41 (a) same number of (gaseous) molecules / moles / volume on both sides of the equation

allow particles for molecules

*do **not** accept atoms*

ignore amount

1

(b) (forward) reaction is exothermic

accept reverse answer

1

(c) any **three** from:

- particles gain energy
- particles move faster
  allow particles collide faster / quicker
  ignore move more / vibrate more
- particles collide more **or** more collisions
- more of the collisions are successful **or**
  more of the particles have the activation energy **or**
  particles collide with more force / energy

3

(d) any **two** from:

- more product (obtained in shorter time)
  accept better yield (of product)
- less fuel needed
  accept less energy / heat / electricity needed

  or

  lower fuel costs
  ignore cheaper unqualified
- less pollution caused by burning fuels

  or

  less specified type of pollution caused by producing heat / burning fuels
  *allow correct specified pollutants caused by burning fossil fuels eg CO_2 / greenhouse gases **or** correct effect of burning fossil fuels eg global warming*
  accept thermal / heat pollution
- using less fuel conserves resources
  accept sustainable
  accept fossil fuels are non-renewable

2

[7]

42 (a) (i) increase

1

(ii) high melting point

1

(b) (i) decreases

1

increases

1

(ii) it gives the particles more energy

1

it makes the particles move faster

1

[6]

43 (a) (i) increase (owtte) **or** gets hotter

ignore gives out heat / takes in heat

1

(ii) any **two** from:

- bonds are strong
  accept hard to break
- a lot of energy needed to break bonds
  allow heat for energy
- all atoms are joined by (covalent bonds
  accept forms lattice
- a large number of bonds would need to be broken

*reference to ionic / metallic = **1** mark*
*intermolecular forces /forces between molecules = max **1** mark*
ignore electrostatic
*many strong bonds need to be broken = **2** marks*
accept 'double bonds' as equivalent to bonds

2

(b) any **two** from:

- particles have more energy
  ignore more vibrations
- particles move faster
  ignore move more
- particles collide more often **or** more collisions
  accept answers such as hit / bump

- more particles / particle collisions
  have the activation energy
  or
  more of the particles / particle collisions have
  enough energy to react
  or
  collisions are more energetic / harder (owtte)
  or
  more of the collisions are successful

  *if electrons rather than particles stated then max **1** mark*

  *there are more collisions and more of the collisions are successful = **2** marks*

  *accept more collisions per second / unit of time for **2** marks*

  *accept 'more successful collisions' for **1** mark*

2

[5]

44 (a) 2.61 / range 2.5 to 2.7

*correct answer with **or** without **or** with wrong working gains **2** marks*

(accept answers between 2.5 and 2.7)

if answer incorrect moles of salicylic acid = 2/138 = 0.0145 moles
*ie 2/138 **or** 0.0145 gains **1** mark*
or
*(180/138) × 2 gains **1** mark*
or
*1 g → 180/138 = (1.304 g) gains **1** mark*
*(**not** 1.304g alone)*

2

(b) 42.1 range 40.7 to 42.3

*accept correct answer with **or** without **or** with wrong working for **2** marks*

*ecf ie (1.1 / their answer from (a)) × 100 correctly calculated gains **2** marks*

*if answer incorrect percentage yield = 1.1 / 2.61 × 100 gains **1** mark*

if they do not have an answer to part (a)
or
they choose not to use their answer then:

- yield = (1.1 / 2.5) × 100 (1)
- = 44

*accept 44 for **2** marks with no working*

2

(c) any **one** from:

- errors in weighing
- some (of the aspirin) lost
  *do **not** allow 'lost as a gas'*
- not all of the reactant may have been converted to product
  eg reaction didn't go to completion
  allow loss of some reactants
- the reaction is reversible
  accept other products / chemicals
- side reactions
  ignore waste products
- reactants impure
- not heated for long enough
- not hot enough for reaction to take place

1

(d) any **one** from:

- use lower temperature
- use less fuel / energy
  ignore references to use of catalyst
- produce product faster **or** speed up reaction
- more product produced in a given time (owtte)
- increased productivity
- lowers activation energy

1

[6]